A PERSPECTIVE ON THE PROBLEM OF RAGA SHRUTIS AND GRAMA-MURCCHANA ANALYSIS

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1. Raga evolution and musical geometry.

The phenomenon of raga is a living continuity of experience and experiment in musical sound (Bor 1975). It is difficult to say how much this phenomenon was guided in its growth and development by a theory of music, and how much it is a spontaneous growth, intuitively groping for and finding possibilities in the particular type of melodic differentiation which raga is: but partly the interest in the question of the intonation of ragas lies in the fact that they show an obvious preference for melodic differentiation within a very few of the possible scale-types.

Six of the now ten most common scale-types of Hindustani music had been identified, and melodies in them were classed into types (*jati*) in the earliest *grama-murcchana-jati* system of musical geometry which was concisely expressed in the *Natyashastra* (Ch. 28: 21-65) (c. 4th C. B. C.). The four remaining can be directly related to the ancient system by relaxing its rules a bit. One can find in the common scales of Hindustani music a differentiation into often as many as twenty-five to thirty separate ragas (cf. Bhathkhande K.P.M.). How old some of these ragas are is difficult to ascertain. There is a fluidity in the names of ragas, where the same name over the centuries has denoted different musical entities, so it is difficult to tell when the main ragas came into existence. To judge from the evidence of early *Sangita Shastra*, melodic entities, or ragas, like *Kaphi*, or *Bhupali*, have probably always existed under different names, but what about ragas like *Gaud Sarang*, *Kedar*, or *Chayanat*, etc.?

Considerations which arise from understanding the relationships of the *shrutis* (enharmonic positions of the notes) among themselves, and the significance of particular collections of them (i.e. scales) in terms of these relationships suggest that there may be a deep grammar to the raga system itself, and a profound rationality to the time and mood theory of Hindustani music. There can no longer be doubt that the ancient Indian theory of musical acoustics found in the *grama-murcchana* theory was capable of locating or pointing in the direction for searching for many, and maybe even most of the principle ragas; but that system has apparently been so ill understood for so many centuries that its effect as a thing by which ragas were discovered is impossible to assess at the present moment (Sharma 1961:37-40).

This ancient theory has attracted much interest, interpretation and speculation, since the time of Sir William Jones, in the attempt to understand and reconstruct that theory in the absence of an authoritative living tradition. In this paper, a look at some contributions to this study is taken in order to point out questions which remain at the frontiers of research in this matter.

2. *Mela* or *thaat* systems of raga classification

The last text of *Sangita Shastra* to have a clear expression of the ancient *shruti-swara-grama-murcchana* system is apparently the *Sangitaratnākara* of Sarngadeva (12th C.)[1] and even that expression has been questioned (cf. Thakur 1956:64-65). Certainly since the Sixteenth Century, both North and South Indian music have favored classification of ragas according to systems of scale-type (*mela* or *thaat*) based on permutations of note possibilities, with the South Indian system taking this to extreme form.

It is necessary to understand someting about the present state of theoretical musical knowledge in North India. North Indian (Hindustani) music is primarily a practical art, and one whose practitioners are largely ignorant of music theory (Framji 1937: 4-5). If one judges the state of knowledge of the past from the evidence of today, or from the Nineteenth Century, it would seem that while there may have been musicians who were conversant with music *shastra* (theory), they must have been quite few (cf. Willard 1834:2).

Most of what passes for theoretical knowledge about music today in North India is a familiarity with the ideas of Pt. V.N. Bhatkhande, who introduced in the early Twentieth Century the classification of Hindustani ragas according to ten scale-types, following the intellectual impetus of the earlier types of North Indian *mela* systems. It is significant that the main degree granting exmining bodies for Hindustani music base their *theoretical* examinations almost solely on the opinions of Bhatkhande.

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[1] *Sangitaraja* of Kumbha, (15th c.) wich generally follows the *Sangitratnakar* also discusses this system in some detail.

In fact, the question of the present-day theory of North Indian music is moot. There is no systematic theory today having any degree of rigorousness, which is both pertinent and precise (Verma 1970: 5). The ancient theory of music took the investigation of the question of the interrelatedness of scales to the level of enharmonic differences, working with a set of twenty-two note-positions (*shrutis*) in the gamut, but when that theory was lost to comprehension sometime after the Thirteenth Century, the *mela* systems which grew up in its place lost sight of the meaning of the original *shrutis* of the ancient division of the octave, and their importance was put in doubt (Sharma, op. cit.).

Followers of the *mela* system methodology gain an apparent advantage, having more scale-types as pigeon holes in which to place ragas, than do the followers of the *grama-murcchana* idea (which looks at scales as modal shifts out of basic scales), but invariably they lose interest in the question of microtonal intonation (*shruti*), because there is no systematic way to relate the enharmonic tunings of the *melas* together (vide Jairazbhoy 1974:72), which can only be identified and linked together through an idea like *grama* (a basic scale) and *murcchana* (its modal shifts). The system of raga classification which Bhatkhande presented ignores completely the question of micro-intervals (criticized by Thakur 1956:60 and Framji 1938:64), and can account for the phenomenon of intonation in Hindustani music just as well by the system of intonation of the piano !

3. Aesthetic implications of just intonation for Hindustani music

Following the laws of musical consonance, any scale of 'n' notes can be consistently tuned in 'n' number of ways. Showing an aesthetic continuity of change, these tunings can be arranged systematically going from darker (more *komal*, flat) to brighter (more *tivra*, sharp); in the same way the diatonic scales can be arranged by type from darker (more minor) to brighter (more major).

It is a striking feature of Hindustani music that the order of the ragas reveals a remarkable regularity of succession of mood linked to the rhythm of the day. As the day warms in the morning going into the afternoon, the ragas move from being predominantly minor to predominantly major. As the late afternoon approaches, they again turn slightly minor. At the dramatic moment of the Indian sunset, they become chromatic; and in the evening when the night is still fresh and hot, they are mostly major, turning slowly to minor as the night progresses. Going into the deep night, the ragas again turn chromatic in anticipation of and to include the dawn (cf. Singh 1968:13).

The same scale-type will usually reappear at intervals of eight, ten, or sometimes twelve hours apart, but shown in a raga which will emphasize different melodic possibilities within the scale-type than was seen previously. What bearing does this have on the *samvad* (harmonic) structure of the raga's scale-type?

4. Raga intonation: the problem of the shrutis

It is possible to ignore altogether the problem of *shrutis* and the question of which of the 'n' tunings for a scale should be used for the particular raga, when musicians tune simply by intuition without concern to check for exact mutual *samvad* between the appropriate fourths and fifths in the scale after they finish tuning, or to play all ragas in a given scale type in one 'standard' tuning, or to play all ragas in equal-tempered intonation, which is the plainest musical palette.

Indeed, one commonly hears the argument that notes of ragas cannot be meaningfully expressed with the accuracy of *shruti* because, it is argued: 1) that in ragas, notes tend naturally to take different positions of pitch, depending on how they are used either in ascent or descent in melodies (Ratanjankar 1940:90 or Powers 1968:53); or 2) in fact musicians do not intone their notes consistently, and the question of *shruti* is, therefore, moot (Jairazbhoy 1973:10).

Of course the use of various types of *portamenti* (meend etc.) which is characteristic of Hindustani music enormously complicates the question of raga-intonation. The idea of a musical scale implies a "ladder of sounds." each note being placed at its desired pitch. In the practice of Indian music, however, one passes from one point on this ladder to other points, usually with a moving pitch-line which in fact passes through all of the intermediary tonal points.[1]

These moving pitch-lines, themselves, however have definite shapes in time which are determined first by laws of consonance, and second by laws of grace and efficiency in moving from one consonant point (*swara*) to another. Even though one may pass through all of the pitch-points of the octave, nevertheless only certain few positions are neatly favored to be shown clearly.

A study of the geometry of musical consonances and scales shows that for a given scale, choices of *swara* pitch-position (*shruti*) are related to the systems of melodic movement (ragas) in the scale. To argue simplistically that a raga's notes should be differently intoned in different melodic contexts is to fail to understand the importance of the unified and consistent geometry underlying the raga system. Furthermore, the fact that musicians cannot always be accurate and consistent in their intonation does not obviate the fact that they should try to be.

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[1] For this reason, some musicians argue that the "*shrutis*" are infinite; meaning by '*shruti*' the intermediate points of the tonal space between the *swaras*. Hence they say, to rest on a *shruti* gives the impression of being out of tune.

The exact relation between moving pitch-lines and the accuracy of *shruti* (which implies a determinable fixed tonal position) is a complex aesthetic, mathematical, and acoustical question, which can be discussed only after a deep scientific study. It may indeed be the case that certain notes in some ragas show a flexibility in their pitch positions; but the questions remain: Which notes, in what ragas, and under what circumstances manifest this fluctuation? Is their a systematic aspect to this phenomenon? Deviations are deviations from what?

The most penetrating analysis of the inner harmony of musical scales, done for the sake of selecting among all possible scales just the most aesthetically balanced ones, is found in the *grama-murcchana* system. The application of this type of analysis to contemporary Hindustani music holds much promise. In the *grama-murcchana* style of analysis each raga can be viewed in the context of other ragas. Since no raga is treated as an entity completely seperated from the rest, any statement about a raga, at this deep level, carries implications for other ragas as well. One cannot see the intricate subtlety of interrelationships among musical scales which are demarcated by *grama-murcchana* analysis, and see that the bulk of the grand ragas lie within the logic of this analysis, and not consider it significant (Framji 1938:64).

5. **Efforts to understand the** *grama-murcchana* **system**

It has been only recently that attempts have again, after centuries, been made to study ragas according to *gramas* and *murcchanas*. First it has been necessary to regain an understanding of the ancient *shruti-grama-murcchana* system. The unravelling of this problem is the story of two handred years of scholarship involving the efforts of both Indians and Europeans. The reacquisition of the understanding of this ancient system was apparently the product of the interaction of the two cultures, since interest in this type of question of intonation was dead both in Europe and India, but for different reasons. The interest was restimulated when European scholars became aware of, and then fascinated, by the existence of an ancient theory of music hitherto unknown to them, and brought to bear on their interest the mathematical tools of musical analysis developed out of the Greek tradition.

Sir William Jones (1784) was the first to draw attention of English language readers to the existence of the ancient Hindu system. By chance he correctly identified the size of the various *shruti* intervals of the Sa-*grama* with the corresponding semitones, whole tones etc. known in Europe. But he did so by virtue of misunderstanding the structure of the ancient *grama,* putting the *shrutis* after the note instead of before it, thus wrongly identifying the ancient Sa-*grama* (which is a type of *Kaphi*) with *Bilaval.*

Jones had suggested that the *shruti* was an interval of one fixed size in addition. When his error on the intervals of the *grama* was discovered, this additional suggestion about the uniform value of the *shruti* seemed inescapable. As Raja Rao Bhandarkar asked, how can you measure with a ruler which is sometimes "an inch. . . sometimes a twelfth of a foot and sometimes a sixteenth?" (Bhandarkar 1912:192) (The series of articles by Bhandarkar which appeared in *The Indian Antiquary* in 1912 are the best summaries of opinion on the subject up to his time.) But this assumption could only lead to dead ends and confusion (Deval 1908:13-14).

It was in the following year that the breakthrough in understanding came when the work done by Deval and Clements with the help of the noted vocalist, Abdul Karim Khan, came to light with the publications of Clement's *Introduction to the Study of Indian Music.* Deval had made many experiments on a monochord with the help of Abdul Karim, and he and Clements became convinced that the positions of the ancient twenty-two *shrutis* were identical to the positions of the notes according to the system of pentadic harmony, or more or less, even simple Pythagorean intonation (twelve note positions obtained following the cycle of fifths and eleven more —since the base remains constant—from the cycle of fourths).

This idea gained ground quickly, apparently, because it was "voted" to be the correct solution to the problem by the All India Music Conference held during Easter week, 1929, in Madras (Ayyar 1950:65)! It never gained the support of Pt. Bhatkhande and his followers, however (Bhatkhande H.S.P. IV:31), and even, for reasons which are unclear, Abdul Karim (Karim Khan 1968:75) later broke with Clements and Deval.

Clements and Deval had understood well the question of the *shrutis.* They were able to correctly interpret the *gramas* and their *murcchanas,* but they did not pursue this question in a systematic way with reference to current practice, a work which was first attempted in the Thirties and Forties by Acharekar and his student Firoze Framji. Unfortunately, Framji's work was presented in a fantastic sort of way making all kinds of claims for itself, which probably hurt more than it helped. Now it is out of print and difficult to get hold of.

In the Forties, this interest caught the attention of Alain Daniélou, whose *Introduction to the Study of Musical Scales* (1943) remains one of the most provocative statements of the importance of the problem. His work done on ragas in successive years makes statements for each raga on the *shruti* positions of the notes of the raga. Unfortunately, he did not go beyond the question of the *shrutis*, their relationships and aesthetic meanings, to the question of the systematics of musical scales.

The most complete work on ragas and scale systematics is Bose's work in the late Fifties, *Melodic Types of Hindustan* (1960). He has tried to bring both the *grama-murcchana* system and the *mela* system together with practice.

One should avoid giving the idea that the line of thought which originated with Deval and Clements has been in any way generally understood and accepted, either by musicians or musicologists. In short, the level of understanding of the problem is not good. Few musicians have any idea what a *shruti* is, and work still appears arguing that the *shruti* is a fixed unit of one size (Te Nijenhuis 1974:14; Jairazbhoy 1975:53). Moreover in the last twenty-five years, another arrangement of the basic positions of the *shrutis* in the division of the octave has been proposed by two important writers in Hindi, Pt. Omkarnath Thakur (Thakur 1956:36-105), the noted musician and scholar, and Pt. Kailash Chandra Brihaspati (Brihaspati 1966:100-106), the late, noted, musicologist and Sanskritist. They have proposed their arrangements on the basis of their understanding and interpretation of the meaning of an ancient experiment with two *vinas* (*catuḥ-sāraṇa*), mentioned in the *Natyashastra,* and following texts, as the touchstone for the determination of the *shrutis* in the *gramas*. They have erred in assuming that the point of the experiment is to show the positions of the *shrutis* in the division of the octave, when in fact, it is to show the value of the 2, 3, and 4-*shruti* intervals in the *gramas* (cf. Bake 1957: 61-67). Their arrangement of the *shrutis* in the division of the octave is, unfortunately, acoustically unsound and has had the effect of adding to the confusion, especially because of the respect held for these men as authorities on music *shastra.*

6. *Grama-murcchana* analysis of contemporary Hindustani music: the frontier of research.

Recent work on *grama-murcchana* analysis of the contemporary practice of Hindustani music, including work done by the present author (Arnold 1974) has shown that the *grama-murcchana* system described in the earliest texts of *Sangita Shastra,* if slightly modified to take account of the current scale-types (*Marva, Purvi, Todi, Lalit,* and *Bhairav*) which were not a part of the original system, provides a number of keen insights into the phenomenon of raga intonation in its relation to raga melodic movement. In addition, it appears to offer the only plausible acoustic basis for the theory of raga performance time. (Arnold 1974).

A truly scientific approach to the question of the acoustical structure of Hindustani music is needed. These and other theoretical claims need to be examined empirically in the light of the best performance practice. In addition, in order to be able to evaluate the discrepancies between music *as geometry* and *music as played*, it is necessary also to study music practice against a background of a study of aberrations of pitch perception (to understand the role of the ear and the auditive system as they influence the perception of a physical pitch) *in the context of a drone.*

In order to do a scientific study of the practice of musicans it is necessary to devise ways to discriminate: (1) what musicians *actually do,* from ...; (2) what they *think* they do; (3) what they *hope* to do; and (4) what musicologists think they should do. The 'tracks' of the actions of musicians must be analyzed and data-processed; musicians must be given various ways to express their intentions; and finally, they must be given ways to measure what they actually do against their intentions.

Since melody in Indian music, as we have noted, is characterized by a number of seperate types of glide which are distinct from each other in their timings—the proportions represented in these timing allowing notes (*shruti*-positions) in a melody to be either stressed, or, to various degrees, only suggested—no study of the intonation of ragas is complete without a careful examination of the nature and shape of this phenomenon. Earlier attempts at such a study have proved necessarily to be inconclusive. The problem is to obtain a sufficient amount of accurate and significant analysis data, over a sufficiently long time period in the exposition of a raga, to evaluate the meaning of particular intonations (which may be now too high, or now too low) in terms of the context of the microtemporal evolution of the melodic line itself as well as the overall development of the raga.

To do such a study, Bernard Bel, acoustician and electronics design engineer, in collaboration with this author, has undertaken the construction of a new type of Melodic Movement Analyzer capable of making a moment to moment measurement of the frequency of the fundamental of a moving pitch line, and the values describing its sound energy spectrum. This analyzer will take its measurements at a rate of from 25 to 100 times per second, and with a accuracy for frequency of approximately one cent (one twentieth of a comma). The information available at the output of the Melodic Movement Analyzer will then be computer processed to extract the significant parameters.

Since it is not possible for a musician to intone his notes always accurately, one must not only examine his tracks, but also one must give him the opportunity to express his intentions, by putting into his hands an instrument on which he can select his own pitches, and experiment with them adjusting them until he is satisfied. To achieve this end, Bernard Bel and this author have created an electronic "*shruti*-harmonium" whose keys are programmable, by introducing ratios into the instrument by means of a calculator keyboard, to give any pitch in the octave within an accuracy of one cent (Arnold & Bel 1980).

This instrument allows a number of experimental possibilities: (1) a musician can produce an exactly known pitch position for a *swara,* and judge it by his ear, adjusting it to his satisfaction for the raga in question; (2) since the instrument includes an electronic *taraf* (imitating electronically the function of resonating strings) he can compare his chosen pitches with his actual practice. (The "*taraf*" only responds when the input signal closely matches in pitch the *shruti* position programmed on the instrument). (3) Finally, the instrument allows any proposed theoretical scale to be rendered in sound, letting musicologists *hear* the scales about which they speculate.

A word of caution on the empirical aspect of this research is in order. To avoid simply adding to the confusion of contradictory opinions which already exist on this subject, the musicians whose music (and whose feelings) are chosen for analysis must be selected very carefully. It does no good to examine a large number of musicians in search of "average *shrutis.*" Every Indian musician has his own ideas about the intonation of ragas, but not every musician *should be* considered an authority. The normative factor in this research is immensely important. Only those masters who have given a lifetime to the practical study of ragas and their intonation (especially *dhrupad* singers, *khayal* singers with a strong *dhrupad* background, and some of the best string instrument players) should be taken as authorities for such a study.

At issue is the question, "How deep does the rationality of the Hindustani raga system really go?" This question has yet no definitive answer.

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